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Sexual Dimorphism and Some of Its Correlations in the Shells of Certain Species of Najades.

BY N. M. GRIER, PH. D.

I.—INTRODUCTORY.

Before Ortmann's discovery that the sex of Najades could be readily learned from associated peculiarities of gill structure, (4, 5,), systematists had only general information—of the type later to be compared in this paper—from which to identify the sex of a mussel when glochidia were. absent. Hazy, (2), and Israel, (3), were able to distinguish the sexes of certain European species by such characters as relative length, height, and inflation. Israel, particularly, found associated with sex, certain colors of the epidermis of the shell. The investigations of these latter writers extended only to 3 species, none of which are closely related to those dealt with in this paper, and their original work never seems to have been followed up. In addition there occur in the papers of American investigators from time to time, scattered references to the sexual dimorphism of certain species based on some morphological feature of the shell. Such, however, are either not concerned with the species we are interested in, or are already summarized by Simpson, (6), or Walker, (8), whose information later will be brought out.

II.—PROBLEM, METHOD, AND MATERIAL.

While pursuing another investigation on the comparative morphological characteristics of certain mussel shells inhabiting the Upper Ohio Drainage and their corresponding ones in Lake Erie, (1) the writer obtained data of the type indicated, which he

proposes in this paper to associate as far as possible with the sex of the shells examined.

The material used was Dr. A. E. Ortmann's splendid collection of shells in the Carnegie Museum at Pittsburgh, Pa., and while the most complete account of how these measurements were taken is reserved until the publication of the research spoken of, the method of making them is described to what is believed to be a comprehensible extent in the accompaning table dealing with sexual dimorphism. Here it may suffice to state that the dimensions taken were 7 in number and included the measurement of,

1.—Relative degree of inflation.

2.—Height.

3.—Posterior length of shell.

4.—Anterior length of shell.

5.—Length of posterior hinge line.

6.—Length of anterior hinge line.

7.—Thickness of shell—in this investigation taken just superior to the pallial line in the region directly beneath the umbo

In making these measurements an ordinary metric caliper and rule were used, the values obtained reduced to convenient factors by division into the length, with the exception of that of thickness, which it seemed desirable to compare with the height.

Measurements were made on the following genera and species, viz.,

Fusconija flava, Raf.	*Paraptera fragilis, Raf.*
Amblema costata, Raf.	*Proptera alata, Say.*
Pleurobema obliquum coccineum, Con.	*Anodontoides ferussacianus, Lea*
Elliptio dilatatus, Raf.	*Eurynia recta latissima, Raf.*
Symphynota costata, Raf.	*Lampsilis luteola, Lam.*
Anodonta grandis, Say.	*Lampilis ovata ventricosa, Lam.*

The factors above described having been obtained, it was the practice while making comparisons in the endeavor to associate any of the 7 measured morphological dimensions with the sex of the shell, to compare equal numbers of both sexes of the species. An average was made of the values obtained by calculation for each dimension of the shell, and then this result compared with that similarly obtained from the other sex of the animal. A table (I) showing the averages for each dimension of that sex of each species is appended, and from the comparison of its values, the table on Sexual Dimorphism (II) is obtained.

III.—Results.

(a.) *Conclusions.*

In more condensed form the results given in the tables may be expressed as follows.

1. Males of Pleurobema, Elliptio, Symphynota, and Proptero possess a greater height and degree of inflation than females and are relatively shorter. The females of Fusconaja, Amblema, Eurynia, L. luteola, and L. ovata show opposite characters in this respect to those of females representing the first four named species. Also in the foregoing, height correlates with the degree of inflation of the shell. Males of Anodonta, Anodontoides while having a greater degree of inflation than females, have a less height.

2. Males of Elliptio, Anodonta, Paraptera, Anodontoides, Eurynia and L. ovata have a relatively greater length of the posterior part of the shell, and consequently less of the anterior. In the remaining shells this condition is reversed.

3. The one outstanding morphological feature associated to preponderating extent with maleness in the Najades dealt with, was the greater length of posterior hinge line, (the anterior seems best developed in the females). These facts correlate with values for anterior and posterior length in ½ the species only.

4. Thickness of shell, as associated with sex, seems to be as equally indifferent as all the other dimensions, (with the exception of those of the hinge lines).

(b.) *Remarks.*

There is now given from Simpson, (6), Walker, (8), Utterback, (7), all descriptive material of the external morphology of these shells usually held to be associated with the different sexes. As a rule, emphasis is placed on Walker's late work, and it is the writer's desire to show the relation of this material to the results he has obtained.

Utterback believed females of *Fusconaja* and *Symphynota* to possess a greater degree of inflation of the shell. My results check only with the former in this respect. We must pass over the other species listed in the order given (for the reason that there seems to be no accredited descriptive material concerning their Sexual Dimorphism), until we come to *Paraptera*.

Simpson: *Paraptera.* "Female and male much alike, former sometimes a little rhomboid or again it ends in a wide rounded point

TABLE II.

SEXUAL DIMORPHISM IN NAYADES.

(Dextro-sinistral diameter $\frac{DSD}{L}$ or convexity of valve divided by length giving *degree* of *inflqtion*)

Male Greater this Respect in	No spec. meas-	ured of each	Female Greater this Respect in
Pleurobema coccineum	15	27	Fusconajo flava
Elliptia dilatatus	15	19	Amblema plicata
Symphynota costata	5	33	Eurynia recta
Anodonta grandis	8	94	Lampsilis luteola
Paraptera fragilis	5	84	Lampsilis ovata
Proptera alata	6		
Anadontoïdes ferussacianus	3		

(Dorso-ventral diameter of $\frac{DVD}{L}$ value divided by length giving *relative height.*)

Male Greater this Respect in	No. spec. meas-	ured of each	Female Greater this Respect in
Pleurobema	15	27	Fusconaja
Symphynota	5	19	Amblema
Elliptio	15	8	Anodonta
Proptera	6	5	Paraptera
Eurynia	33	8	Anodontoides
		94	L. luteola
		84	L. ovata

(Distance posterior to extremity $\frac{PD}{L}$ from aline passing through median dorsal plane of valve expressing *relative;degree posterior development shell.*)

Male Greater this Respect in	No. spec. meas-	ured of each	Female Greater this Respect in
Elliptio	15	27	Fusconaja
Anodonta	8	19	Amblema
Paraptera	5	15	Pleurobema
Anodontoides	3	5	Symphynota
Eurynia	33	6	Proptera
L. ovata	84	94	L. luteola

(Distance anterior to extremity $\frac{AD}{L}$ from a line passing through median dorsal plane of valve expressing *relative degree anterior development shell.*)

Male Greater this Respect in	No. spec. meas-	ured of each	Female Greater this Respect in
Fusconaja	27	15	Elliptio
Amblema	19	8	Anodonta
Pleurobema	15	5	Paraptera
Symphynota	5	3	Anadontoides
Proptera	6	33	Eurynia
L. luteola	94	84	L. ovata

(Length of shell compared $\frac{PHL}{L}$ with that of posterior hinge line.)

Male Greater this Respect in	No. spec. measured of each		Female Greater this Respect in
Fusconaja	27	5	Symphynota
Amblema	19	6	Proptera
Pleurobema	15	5	Paraptera
Elliptio	15		
Anodonta	8		
Anodontoides	3		
Eurynia	33		
L. luteola	94		
L. ovata	84		

(Length of shell compared $\frac{AHL}{L}$ with that of anterior hinge line.)

Male Greater this Respect in	No. spec. measured of each		Female Greater this Respect in
Symphynota	5	27	Fusconaja
Proptera	6	19	Amblema
Paraptera	5	15	Pleurobema
		15	Elliptio
		8	Anodonta
		3	Anodontoides
		33	Eurynia
		94	L. luteola
		84	L. ovata

(Thickness of shell divided $\frac{TH}{DVD}$ by dorso-ventral diameter.)

Male Greater this Respect in	No. spec. measured of each		Female Greater this Respect in
Pleurobema	15	27	Fusconaja
Elliptio	8	19	Amblema
Anodonta	8	5	Symphynota
Proptera	6	5	Paraptera
Anodontoides	3	94	L. luteola
Eurynia	33		
L. ovata	84		

about in the median line. Female shell a little fuller and more rounded in the post-basal region." Specimens of Paraptera were not abundant, but if in this species "rhomboidal" may generally imply a greater height compared with the length, there is some agreement on the part of my results. Inflation of the post-basal region was not measured.

Proptera: "Female shell with long rounded marsupial swelling at extreme post-basal part, generally sub-truncate behind. Male shell less full in post basal region, nearly rounded behind." My

observations do not agree with calculations from Walker's illustration of this species which shows the female to be relatively higher. They do agree in assigning the female a greater posterior length of shell.

Eurynia: "Male shell drawn out behind and ends in a blunt point about midway up from the base. Female shell has long rounded marsupial swelling, ending in a blunt point $2/3$ way up from the base." This data agrees with my measurements, as it may be inferred the male is longer, the marsupial swelling may be in evidence from the inflation of the shell at the point measured.

L. luteola: "Female shell with most decided marsupial swelling; here blunt posterior point is somewhat higher up, ($\frac{3}{5}$), of height than that of male, (about halfway), and is usually more inflated." My results show the female as a higher degree of inflation, and is besides relatively longer.

L. ovata: "Female shell slightly inflated post-basal region," etc. As the recorded dimorphism for this genus is practically the same as for these last 2 species, I need only point out the full accord with my results.

The value of quantitative studies of the morphological characteristics of shells is best appreciated when cases are brought back to mind where new genera and species had to be founded on the anatomy of soft parts alone so great was the superficial resemblance in some cases between what turn out to be entirely different animals. If as a general proposition, it be admitted that the systematist should be able to find in any organism *specific characters* distributed from the most minute anatomy to the coarsest features of morphology, any such convergent phenomena as described above could be eleminated as each species of shell could be expected to vary in morphological characters around its own mean. It is to be hoped that the practice of publishing the more usual dimensions for *both* sexes of shells will be continued, that the ultimate philosophic trend of all Biological Science may have ample data for the consideration of the never-dying and always-puzzling question of the environment.

(*c.*) *Source of Error.*

Paucity of material compelled me to use in some species a few shells from Lake Erie, (most were from the Upper Ohio Drainage), although it is in some of the measured shell characteristics, as I expect to show, that the Lake Erie shells differ from those of the

Upper Ohio. I do not feel, however, that the value of my conclusions is greatly impaired thereby, as an equal number of shells of both sexes from Lake Erie was included when this had to be done. Besides the reduction to factors apparently expresses the relative proportion of the part concerned, and, by the law of averages, possibly evens up any great differences.

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TABLE I.

GIVING AVERAGE DIMENSIONS OF MALE AND FEMALE SHELLS.

NO. SPECIMENS	MUSSEL	SEX	DSD / L	DVD / L	PD / L	AD / L	PHL / L	AHL / L	TH. / DVD
27	Fusconaja flava	♀	.5294	.7756	.7749	.2315	.4867	.2499	.119
27	Fusconaja flava	♂	.4838	.7710	.7550	.2308	.544	.2001	.1181
19	Amblema plicata	♀	.409	.710	.806	.198	.574	.184	.1398
19	Amblema plicata	♂	.437	.7680	.813	.1892	.565	.184	.1699
15	Pleurobema obliquumcoc	♀	.436	.796	.845	.1552	.594	.1987	.43
15	Pleurobema obliquumcoc	♂	.442	.821	.78	.2145	.575	.1973	.27
15	Elliptio dilatatus	♀	.297	.494	.774	.2115	.509	.1830	.24
15	Elliptio dilatatus	♂	.304	.505	.796	.2026	.544	.1615	.22
5	Symphynota costata	♀	.260	.566	.744	.256	.490	.1924	.24
5	Symphynota costata	♂	.287	.586	.729	.270	.497	.253	.26

8	Anodonto grandis	♀	.372	.567	.716	.277	.418	.216	.061
8	Anodonto grandis	♂	.382	.561	.709	.288	.419	.243	.062
3	Anodontoides ferussac	♀	.373	.517	.763	.306	.472	.242	.40
3	Anodontoides ferussac	♂	.357	.518	.754	.248	.436	.182	.35
5	Paraptera fragilis	♀	.355	.751	.734	.268	.502	.2081	.10
5	Paraptera fragilis	♂	.304	.696	.737	.267	.491	.2215	.16
6	Proptera alata	♀	.361	.775	.684	.315	.539	.219	.34
6	Proptera alata	♂	.373	.825	.708	.292	.561	.2185	.19
33	Eurynia recta	♀	.2740	.412	.774	.2229	.540	.1676	.55
33	Eurynia recta	♂	.2703	.4177	.798	.207	.560	.1616	.28
94	Lampsilis luteola	♀	.4027	.6036	.7603	.2739	.5184	.2478	.38
94	Lampsilis luteola	♂	.3708	.5617	.7319	.2593	.4878	.2191	.38
84	Lampsilis ovata vent.	♀	.4780	.7375	.6885	.3105	.4490	.2314	.39
84	Lampsilis ovata vent.	♂	.4660	.716	.706	.297	.451	.2319	.38

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The Prairie Mirage.

BY HOWARD C. BROWN.

Strange is it indeed, that to so many persons who have spent their lives upon the prairie, a mirage is something which is far distant; a thing entirely unrelated to their life. Many persons associate the mirage only with the desert. This seems odd enough when one considers the many beautiful mirages which appear in the prairie skies when a reflected grass area seems only a further extension of the vast, real stretch, which, in great, gentle waves of Titanic magnitude, roll, of a prairie morning, in undulating green, wind responsiveness, under the lifting sun. Few things can inspire one with more sincere thoughts of the greatness of the universe, than can the wide stretches of prairie of our land. And the mirages are interesting to me in that they were often so thoroughly linked, in the past, with the life of the pioneer.

If he loved beauty, the pioneer never ceased to revel in those wondrous reflections. But the mirage was not alone a thing of beauty. If it mirrored an enemy's camp, in time of hostilities, it served a utilitarian purpose. But to those who did not love it for its beauty, and for whom it served no real purpose, still it became